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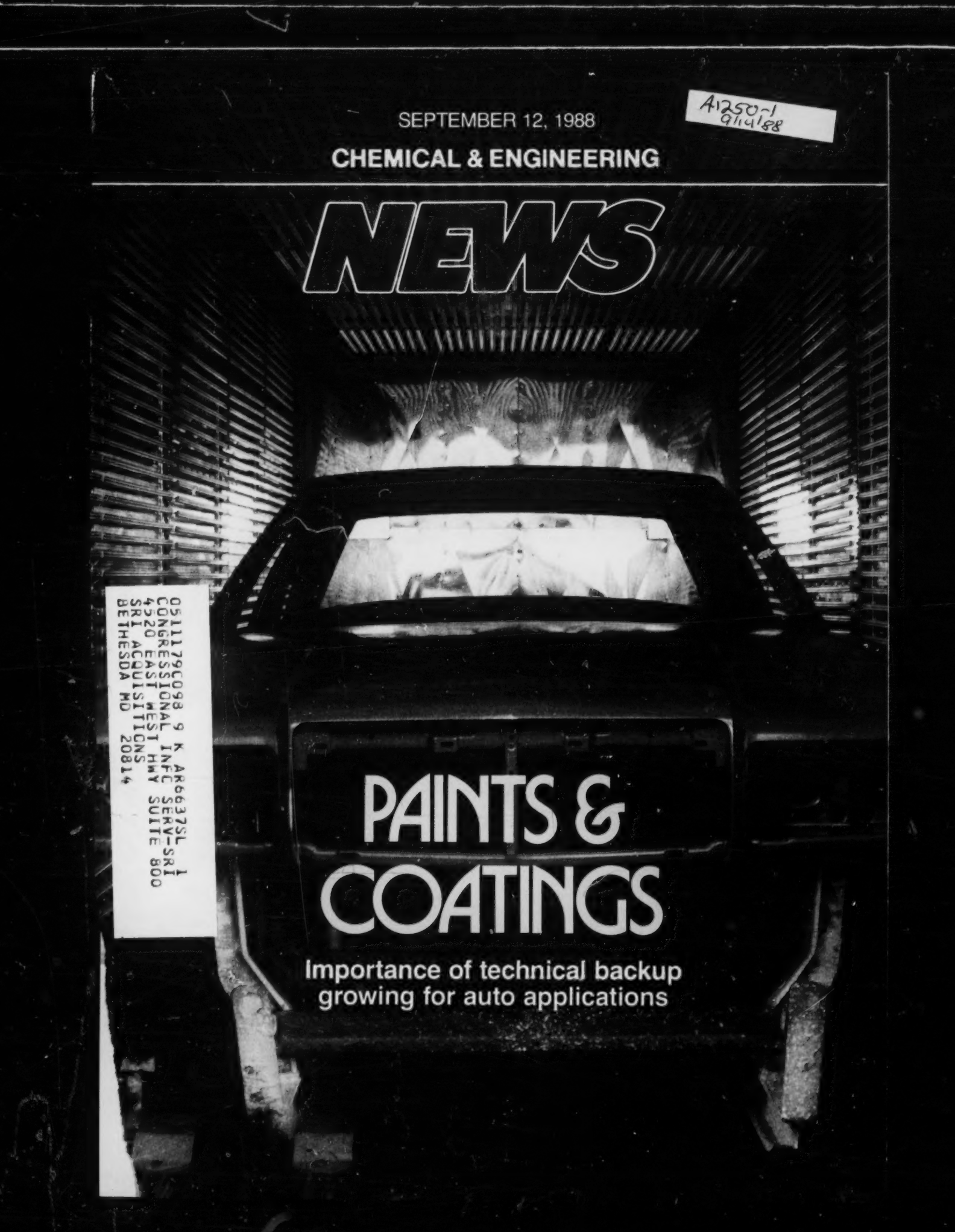
SEPTEMBER 12, 1988

CHEMICAL & ENGINEERING

NEWS



PAINTS & COATINGS

Importance of technical backup growing for auto applications

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CHEMICAL & ENGINEERING NEWS

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SEPTEMBER 12, 1988

News of the Week

■ **In technology policy report aspiring to influence election debate, the Council on Competitiveness of Washington, D.C., urges improved national policy to help industry perform better in global competition.** **Page 4**

■ **Occupational Safety & Health Administration rebuts charges of lax enforcement.** **Page 5**

■ **Dow Chemical works out merger agreement with Essex Chemical, rescuing Essex from a possible hostile takeover by Gurit-Heberlein.** **Page 5**

■ **Breaking with tradition, England's Oxford University launches two private-sector initiatives.** **Page 6**

■ **British researchers are successful in fabricating polyacetylene semiconductor devices.** **Page 6**

Cover: Combination convection/medium-wave infrared oven for drying auto coatings at Du Pont's Finishes Applications Lab in Troy, Mich.

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Government

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Final site selection for the Superconducting Super Collider can now proceed after Department of Energy's release, last month, of draft environmental impact statement for the project. **Page 21**

Technology

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Four new engineering research centers approved by National Science Board have chemistry components. **Page 29**

Books

"Nuclear Imperatives and Public Trust," by Luther J. Carter, confronts events and politics leading to nuclear waste problems and solutions that face noncommunist countries. **Page 81**

Product Report

As paints and coatings sales hit new highs, focus by major producers is on technical applications labs to better service the lucrative auto market and on performance paint materials. **Page 37**

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LETTERS

Attracting chemistry students

SIR: In response to the national trend toward fewer science majors, our department continuously strives to attract students to chemistry. One of the most successful efforts in this regard has been a one-day chemistry symposium for high school seniors. I pass along this information, hoping that it can be helpful to other chemistry departments.

The symposium was held in conjunction with Colgate's annual "subfrosh" weekend, where students of all interests spend a Sunday and Monday in April visiting the campus as a group. Our program began Saturday morning with a welcoming reception and tours of our laboratories. Next came a discussion of the chemistry curriculum at Colgate and the possible careers stemming from a chemistry major. After lunch with Colgate's present chemistry majors, the visitors got some hands-on experience using our equipment and computers while performing an experiment that spectrophotometrically determines the phosphate content of soft drinks. The rest of the afternoon was spent discussing current chemistry research at Colgate with our chemistry majors. Our research students prepared posters depicting their undergraduate projects. The high school seniors had dinner with the chemistry faculty followed by an informal gathering at the chairman's home.

The success of this day is already evident. Of the high school students who participated, two thirds will attend Colgate this fall. Their familiarity with our department and faculty will certainly have a positive impact on our enrollments.

I encourage secondary school teachers interested in our program to contact me.

Carla M. Verschoor
Assistant Professor of Chemistry
Colgate University

General chemistry texts

SIR: Recently, a number of my colleagues and I who are responsible for teaching general chemistry at Adelphi University went through the ritual of choosing a new chemistry text. We were overwhelmed by the extraordinary production that went into the new crop of general chemistry texts. They are all four-color (or all color given the shadings available), make copious use of color plates, have breathtaking drawings, wonderful photographs, and all together comprise a book of some 25 chapters.

The written page is no longer simple. There are inserts, sidebars, boldface, italics, and examples peppered throughout. At the end of each chapter there are some 50 problems along with a glossary of important new words, a summary of the important highlights of the chapter, and definitions of those words that were defined in the body of the chapter. But this is not all. Bundled with each text is a multitude of accessories. We may find: lab manual, study guide for students (answer book), test bank, overheads, instructor's guide to text, instructor's guide to lab manual, test bank on software, and video.

And now to the heart of the matter—the textbook. It is clearly overproduced. It would be more fitting to spend its time as a coffee table ornament than a chemistry text. The colors, the plates, the extras, the gimmicks, the overburdening wealth of material, is too, too much. I could list some 20 topics and more than five chapters that can easily be omitted. I'm sure most teachers can do the same.

The whole package has become unconscionably wasteful and pedagogically unnecessary. Are the publishers solely to blame? Each publishing house must keep up with what is being presented by the competition or risk losing adoptions. I've been told that a publishing house must commit approximately a half million dollars to do a general chemistry text. A one-book failure could easily bankrupt a small- to medium-size company. What are the consequences of this reality?

Publishers will only publish a book that they truly believe will be a best-seller. This means that unknown authors will probably be rejected. Any manuscript that one publisher rejects will be labeled with a bad history. Innovations in presentation style, ordering of topics, along with any revolutionary thoughts in general chemistry teaching, have almost a zero probability of being published. The publishers need a sure thing to protect their investment.

We cannot look to the publishers to change. We are the consumers and it is up to us to ask them to publish texts that are reasonable in length, cover those topics that should be taught in general chemistry (not elementary physical chemistry, not organic chemistry, not biochemistry, not a beginner's course in environmental chemistry, and so on), uncluttered and devoid of those wasteful additions to the package.

Stanley Windwer
Professor of Chemistry
Adelphi University

Canadian Chemical Industry Enjoying Banner Year

But a stronger Canadian dollar, rising interest rates, and a possible slowing of economic growth could spell trouble ahead for the industry

The Canadian chemical industry is well on its way to chalking up a banner year. Production and shipments are up. Exports are strong. Sales are booming. Buoyed by higher selling prices, earnings are in many cases at record levels (C&EN, August 22, page 13).

With shortages in many key chemicals, Canadian chemical companies are hitting the expansion trail in force. Ethylene, styrene and polystyrene, sodium chlorate, hydrogen peroxide—even nitrogen fertilizer—are some of the many chemicals that are already ticketed or at least being considered for expansion projects.

In a recent report, Alberta's Energy Resources Conservation Board (ERCB) says that new investment in the province's petrochemical industry could top $2 billion (Canadian, 1971 dollars) by the year 2002. That's about $1.6 billion (U.S.) at current exchange rates. Major projects, says ERCB, would include ethylene, methanol, and possibly ammonia.

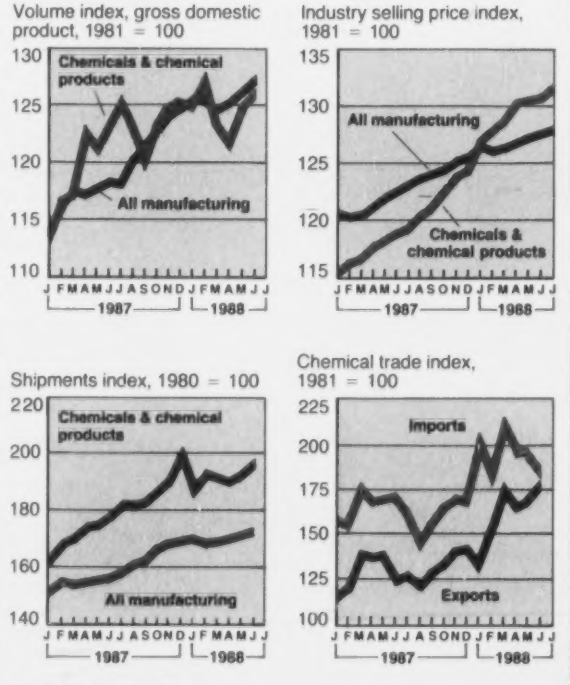
But a growing number of experts, both inside and outside the industry, are concerned that the Canadian chemical industry may be in danger of repeating its major mistake of the early eighties—adding new capacity at exactly the wrong time. Three things are triggering this concern. One is a strengthening Canadian dollar. Another is rising interest rates. And the third is the very real possibility that the six-year binge of economic growth will either grind to a halt or, more likely, at least slow down.

Methanol is the big gainer

Production, thousands of metric tons	1987	First five months 1988	First five months 1987	% change 1987–88
ORGANICS				
Benzene	720	304	313	−2.7%
Butadiene	167	74	71	4.3
Ethylene	2140	970	888	9.2
Formaldehyde	122	48	53	−9.4
Methanol	1627	887	625	42.2
Propylene	628	260	260	0
Toluene	396	176	168	5.1
Xylene	345	193	137	40.8
PLASTICS				
Polyethylene, low density	1021	468	424	10.5
Polyethylene, high density	269	140	113	23.9
Polyesters, unsaturated	47	19	19	0
INORGANICS				
Hydrochloric acid	164	71	64	11.8
Nitric acid	900	376	441	−14.6
Phosphoric acid[a]	464	205	223	−8.4
Sulfuric acid	3437	1636	1613	1.5
Ammonia, anhydrous	3512	1747	1547	13.0
Ammonium phosphate	941	426	467	−8.7
Chlorine	1635	692	672	3.0
Sodium hydroxide	1770	765	737	3.9

a 100% P_2O_5. Source: Statistics Canada

Chemical shipments, exports, and prices all rise


Volume index, gross domestic product, 1981 = 100
Chemicals & chemical products
All manufacturing
Industry selling price index, 1981 = 100
All manufacturing
Chemicals & chemical products
Shipments index, 1980 = 100
Chemicals & chemical products
All manufacturing
Chemical trade index, 1981 = 100
Imports
Exports
J F M A M J J A S O N D J F M A M J J
1987
1988

Source: Statistics Canada

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CIRCLE 87 ON READER SERVICE CARD

Paul H. Williams, president of Celanese Canada, warns that if the Canadian dollar continues to strengthen, his company's export prices could be hurt. That means that profits also would be affected. The reason, of course, is that a stronger currency makes exports more expensive and less competitive in international markets. Conversely, it makes imports less expensive and more competitive in the country's domestic markets.

Williams' concern should extend well beyond his own company, because exports are critical to many companies in the Canadian chemical industry. Many of the world-scale petrochemical plants built in the country depend on exports for well over half of their sales.

Despite the stronger Canadian dollar, Canadian chemical exports are up a hefty 31% through the first half of the year. Imports, meanwhile, are running only 21% higher. If the first-half trend continues, Canadian chemical exports could hit $6.6 billion (U.S.) this year and turn the country's chemical trade deficit into a surplus.

However, if the Canadian dollar continues to strengthen as it has, that possibility could be aborted. Last month, the Canadian dollar's average value against the U.S. dollar was 81.7 cents. At the start of the year, it was only 77.9 cents. A year ago, it was 75.5 cents, and not very many years ago the Canadian dollar was equal to only 72 U.S. cents.

Canadian chemical exports have surged despite the stronger Canadian dollar because overseas demand for petrochemicals has been so strong. Now many wonder how long the world's economies can sustain that demand level.

They wonder, too, about the Canadian economy. It has been robust this year, with growth pegged between 3.5 and 4.0%. But, as in the U.S., strong economic growth unleashes inflation fears—and inflation fears trigger higher interest rates. To round out the cycle, higher interest rates put a damper on economic growth.

Last month, the prime rate in Canada rose to 11.25% from 10.75%. Many Canadian economists think that it will go higher still, if not this year, then certainly sometime next year. These higher rates could have a twofold impact on Canadian chemical companies. First, they could decelerate economic growth. Estimates of Canadian economic growth in 1989 center around 2.1 to 2.2%. That would mean less demand for chemicals. Couple that with the lower demand expected in export markets and the result would be less chemical sales and lower chemical profits.

The other impact of higher interest rates is stiffer costs on the debt burden needed to finance planned expansions. Canadian chemical companies got badly burned in the early 1980s when interest rates soared and markets collapsed.

Remembering those costly lessons, balance sheets of most Canadian chemical companies are in much better shape now than they were then. As a result, they may be better able to cope with rising interest rates than they were in the early eighties. So far, at least, the industry leaders don't appear to be worried about their expansion plans or the prospects of weaker markets. Some say they should be.

Meanwhile, existing plants are running at or near full capacity. As they have for several years, ethylene and its derivatives continue to sport healthy growth rates. Through the first five months of the year, ethylene output was 2.1 million metric tons, 9.2% higher than in last year's corresponding period. Low-density polyethylene output was up 10.5%, and that of its high-density counterpart was a whopping 24% higher.

Output of methanol, which has had more than its share of problems over the past few years, is ahead of last year's pace by a staggering 42%. And fertilizers, whose markets also have been depressed, are also staging a comeback. Ammonia production, which has declined for the past two years, was 13% higher through the first five months. And urea output was up almost 15%. Even sulfuric acid output, which has been dropping since 1984, was higher this year, if only by 1.5%.

Earl Anderson

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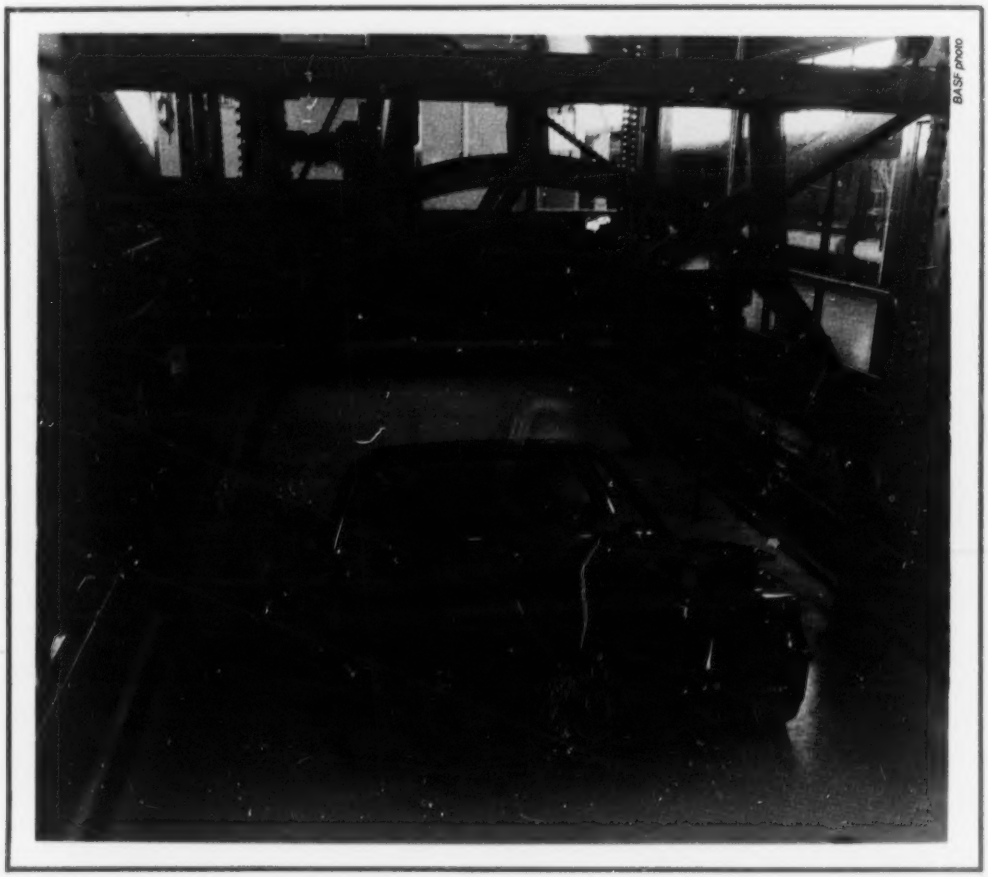


Paint Sales at 10-Year Peak

Marc S. Reisch,
C&EN Northeast News Bureau

Record demand for paints and coatings pushed shipments beyond 1 billion gal last year, making it by far the best year for this industry in terms of volume since 1977. The value of shipments also peaked at over $10 billion, and industry executives believe that 1988 could be an even better year.

This three-part article examines the general U.S. paint market depicted by government figures, the U.S. automotive paint industry, and high-performance coatings.

Beginning on page 38, U.S. government figures not only portray the size of the market, but show where demand for coatings appears to be strongest. Not surprisingly, the increased demand for product coatings in the face of a weaker U.S. dollar has made U.S.-produced industrial goods competitive again in the world market.

Beginning on page 48, the huge market for paints in the auto industry is explored. Although auto production has not benefited from increased overseas demand to any great degree, there is a potential for that to happen in the future. Some see a better automotive production market ahead in light of Honda's exports of passenger cars from its Marysville, Ohio, facility. They find added significance in the number of Japanese auto makers who are setting up assembly lines in the U.S. Should the U.S. significantly increase auto production, paint manufacturers such as Du Pont, PPG Industries, and BASF—the three largest U.S. producers—would benefit.

The automotive market today remains a highly competitive one. It is a market driven not only by changes in chemistry but also by the demands of auto makers who want the best corrosion protection and the most appealing finishes they can acquire for their car lines. In a world where car production capacity is higher than real demand, paint is one element that auto makers can use to gain the market share each needs to survive.

To meet the demand, the Big Three paint makers are investing in technical applications labs to ser-

vice the auto industry like they never have before. The investments are in the millions of dollars, and are considered pivotal not only in helping Detroit but in helping world auto makers achieve better-quality finishes with lower volatile organic chemical (VOC) emissions. The paint producers consider the investments pivotal in their own quest for greater share of market, too.

Beginning on page 79, performance paint materials are highlighted. One major innovation is a new fluoropolymers coating technology that allows chemical process vessels to operate smoothly and efficiently under some of the most adverse conditions.

Shipments continue to rise

U.S. manufacturers shipped slightly more than 1 billion gal of paints and coatings in 1987, according to the Department of Commerce. That volume of shipments marked a 1.7% increase over the previous year's shipments and marked a 10-year high for the industry. The last time paint, varnish, and lacquer production exceeded 1 billion gal in the past 17 years was in 1978.

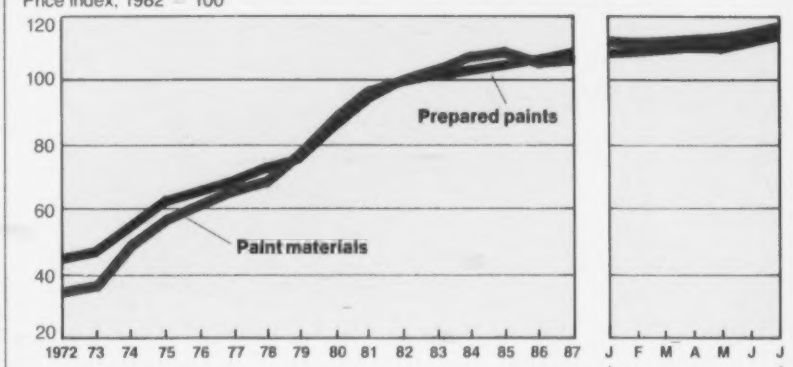
Even better news for paint manufacturers: The value of all paints and coatings shipments in 1987 reached $10.2 billion. That sales figure is 7.4% higher than in 1986.

Higher-value paints sold into all three major market categories—architectural coatings, product coatings, and special-purpose coatings—account in large measure for the growth in value in excess of shipments.

The good news should not have come as a surprise to those close to the industry. The strength of the economy overall and the recent resurgence of heavy industry have helped fuel the demand for more paints and coatings.

In addition, the decline in the value of the dollar relative to most major foreign currencies has helped make U.S. merchandise more competitive worldwide and thus has helped fuel sales of product coatings in particular. Conversely, the weakness in the dollar has slowed the demand for imported products, thereby increasing market share for U.S.-made durable goods.

Rise in paint materials prices is outpacing that of paint

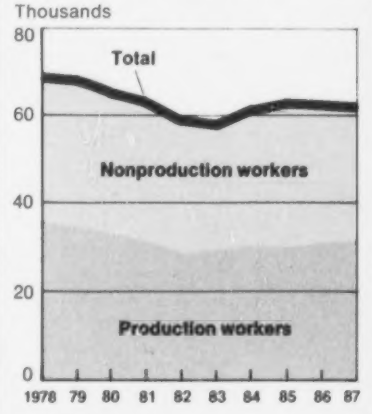


Source: Department of Labor

U.S. paint makers have been the beneficiaries of the improved market performance of domestic manufacturers. Although 35%, or 350 million gal, of domestic paint shipments were designated for the product coatings category in 1986, 36%, or 360 million gal, of all shipments went into the product coatings category in 1987. Shipments of paint within the product coatings segment, which includes automotive finishes, grew at a faster rate—2.9%—than for all paints and coatings.

More recent figures for the first quarter of 1988 indicate that the year as a whole promises to be better than 1987. Shipments were up 4.2% to 244 million gal for the first three months of 1988 compared with

Paint production worker employment up again



Source: Department of Labor

Three main paint categories break down this way

Architectural coatings
- Exterior house paints
- Interior house paints
- Undercoaters, primers & sealers
- Stains

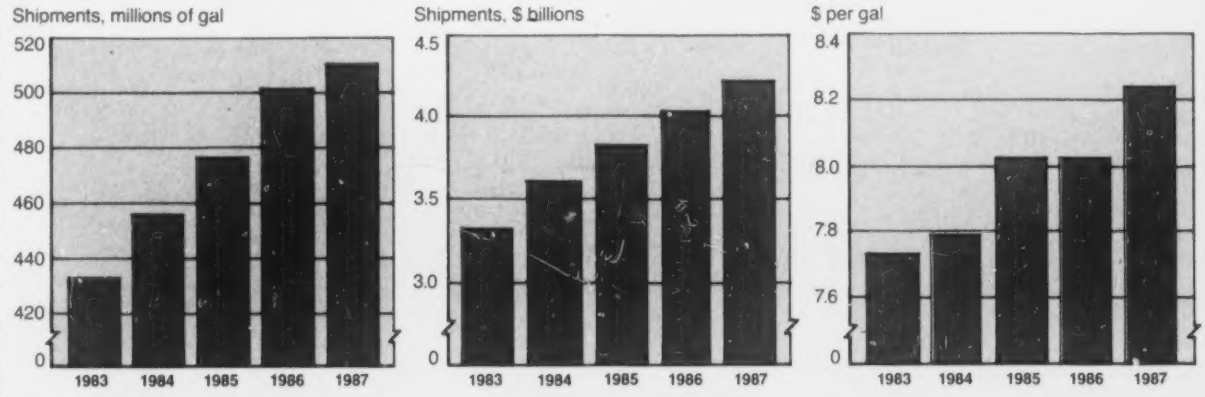
Product coatings[a]
- Wood furniture & fixtures
- Automotive
- Metal containers
- Machinery & equipment
- Factory-finished wood
- Metal furniture & fixtures
- Sheet, strip & coil
- Nonautomotive transportation
- Appliances
- Electrical insulation
- Marine
- Film, paper & foil
- Pipe
- Toys & sporting goods
- Miscellaneous consumer & industrial products

Special-purpose coatings
- Automotive & machinery refinishing
- High-performance maintenance
- Traffic paint
- Roof coatings
- Bridge maintenance
- Aerosols
- Swimming pool coatings
- Arts & crafts
- Metallic coatings
- Multicolored coatings

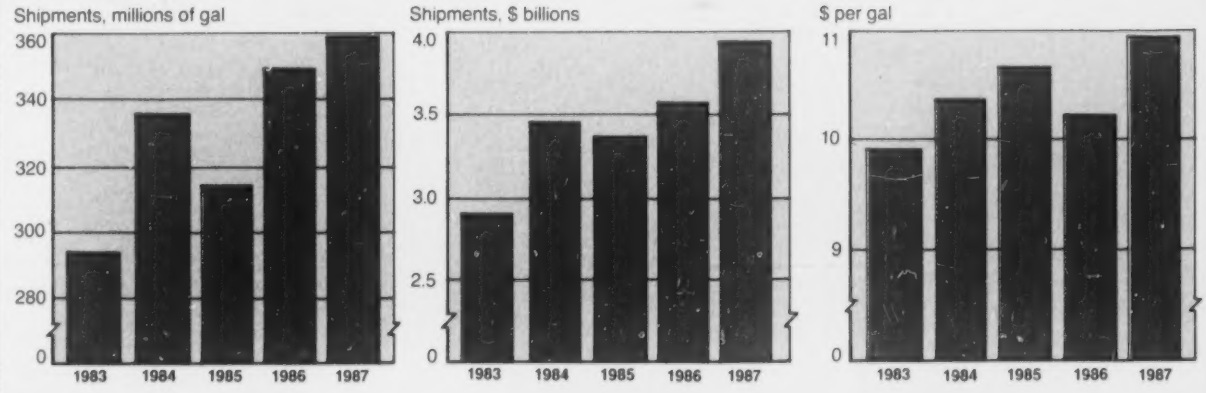
a Original equipment manufacturers. Source: SRI International

Prices rise in all categories, shipments up for architectural, product coatings

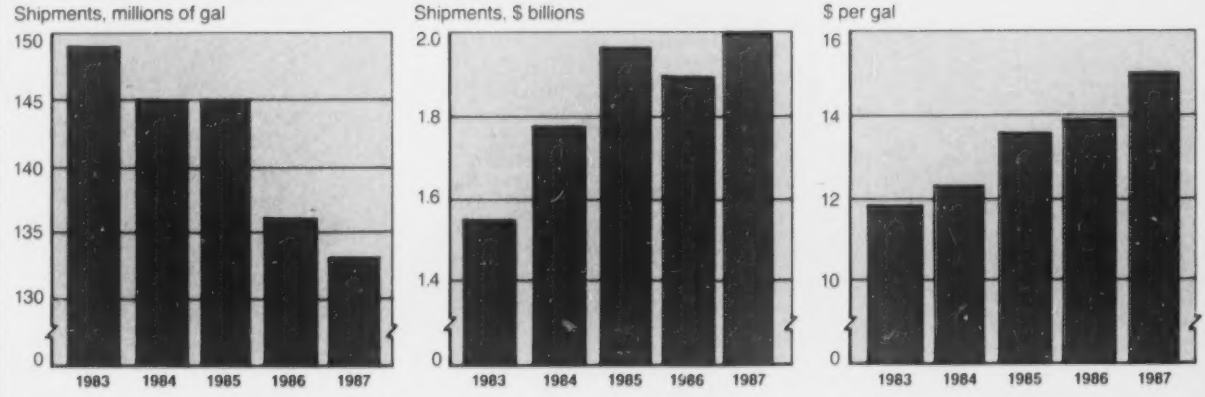
Architectural coatings



Product coatings[a]



Special-purpose coatings



a Original equipment manufacturers. **Source:** Bureau of the Census

the same period last year. Shipments also increased in each of the major categories during the first three months of this year. Shipments of architectural coatings, at 118 million gal, were 3.0% ahead of the same period in 1987; product coatings increased 2.5% to 92 million gal; and special-purpose coatings grew at a much higher than usual rate of 14% to 34 million gal.

The value of paint shipments for the first three months of 1988 also increased. The government figures show that the cumulative value of shipments in the first quarter of this year was up 13% from last year's first quarter to $2.6 billion. Architectural coatings increased in value 4.2% to $959 million. The value of product coatings increased almost 15% to $1.1 billion, and the value for special-purpose coatings increased 12% to $492 million.

The paint market remains a highly cyclical market dependent in large measure on the overall economy, and government data indicate that the economy has continued to be strong during the first part of 1988. Gross national product, seasonally adjusted, was up 5.1% in constant dollars during the first quarter of 1988 from the fourth quarter of 1987. Most observers remain confident that 1988 will be a good year for industrial growth, though they remain cautious in their predictions following the Presidential elections this November.

Industry analysts predict that 1988 will be a good year overall for the paint industry. James A. Rauch, president of Rauch Associates, Bridgewater, N.J., forecasts slow but steady growth for the industry, though he notes that use of decorative powder coatings is growing faster than the industry as a whole. However, he points out that powder coatings are a very small segment of the overall market.

Jeffrey Back, project manager for industry analyst Kline & Co., says the product coatings market for original equipment manufacturers (OEM) is now positioned for the strongest growth, in part because of the many foreign-based auto makers setting up manufacturing sites in the U.S. However, architectural coatings markets will soften, says Back, mostly because of a slowdown in housing and office construction.

Within the special-purpose coatings category, plant and equipment maintenance coatings may not be so strong a market in 1988 as it has been in the past few years. Companies have not only kept up maintenance schedules on existing plants, they have accelerated maintenance programs because they were flush with cash, explains Back. As a result, Back expects the maintenance segment to lag for the next year or two.

Bridge coatings, also included under the special-purpose category, have not been as strong a market as much of the recent talk concerning rebuilding decaying inner city bridges would indicate. Although a few dilapidated bridges have been the subject of national discussion, such as New York City's decaying Williamsburg Bridge or the collapsed Mianus River Bridge on the Connecticut Turnpike, there has been no real discernible increase in money spent on bridge maintenance, says Back. The industry is still waiting, he says.

A 1987 profile of the paint and coatings industry based on Bureau of the Census figures shows that architectural coatings, which include both interior and exterior house paints, make up a little more than half of all paint sold in the U.S. Product coatings for the original equipment market, which includes automotive and appliance coatings, account for some 36% of U.S. paint volume. And special-purpose coatings comprise about 13% of total paint shipments. That category includes large-volume maintenance items, automotive refinishing, and coil coatings.

Shipments of architectural coatings last year increased 1.8% from 1986 to 510 million gal. However, the value of shipments rose at a faster pace—up 4.7% last year to $4.21 billion. The unit price per gal also increased 2.7% compared with 1986 to $8.24.

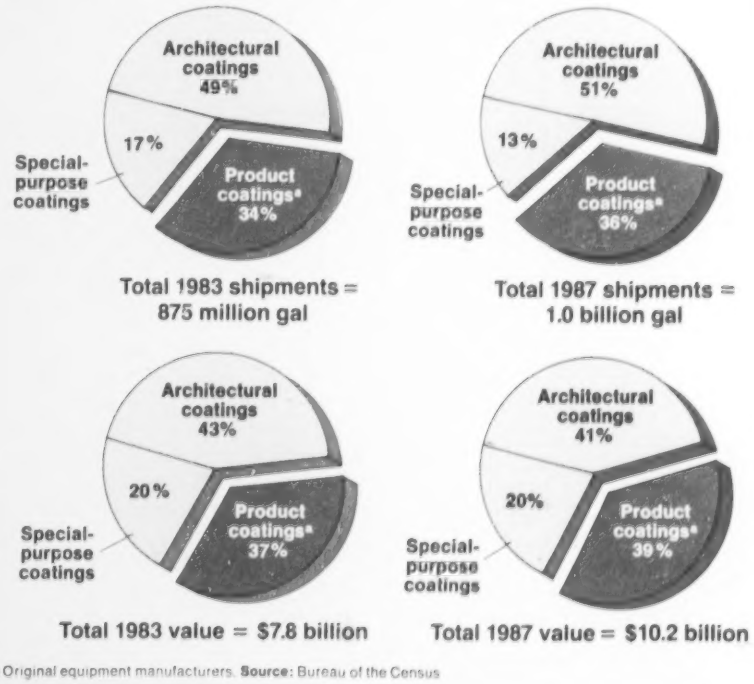
Product coatings shipments for the OEM sector increased 2.9% in 1987 to 360 million gal. The value of those shipments climbed 10% to $3.95 billion. Unit price per gal also increased to $10.95, up 6.9% from 1986.

The special-purpose coatings category was the only one to report an actual decline in shipments in 1987—down 2.2% from the year earlier to 133 million gal. The value of those coatings shipments, however, increased 5.3% to $2.0 billion. Unit price per gal increased significantly—up 7.6% to $15 per gal.

Just over 1000 U.S. companies are still active paint manufacturers, down from 1125 in 1983, according to consultant Rauch. Despite the number of highly publicized mergers and acquisitions in recent years, the industry remains highly competitive.

Because of the competition, product advances do not immediately translate into huge profits. Compet-

Product coatings grow in both shipments and value, although architectural uses remain the leader



a Original equipment manufacturers. **Source:** Bureau of the Census

Mobay photo

Bridge in downtown Pittsburgh is protected by three-coat paint system

itors quickly catch up with advances of their own. Pricing is often a manufacturer's key to a larger share of the market and thus greater profits. And since the competition is so keen, manufacturers often temper price increases even though raw material costs increases have frequently outpaced paint price increases.

Shortages of materials have in some cases bid up the prices of paint raw materials, including ethylene-based solvents and titanium dioxide. Thus the first six months of this year have witnessed raw materials price increases greater than what paint makers have either been able or been prepared to pass along to their customers. From January to June 1988, the index for paint material prices increased 4.5% to 116.0 (1982 = 100), according to Labor Department figures. During the same period of time, the index of prepared paint prices has increased only 3.0% to 112.7 (1982 = 100).

The disparity between increases in raw materials and prepared paint prices was similar between 1986 and 1987. Raw material prices last year increased 3.2% from 1986 to an index of 107.7, and prepared paint prices increased 1.2% to an index of 108.3.

For the second year in a row, paint manufacturers continued to produce more paint in 1987 with fewer employees. According to Department of Labor statistics, the total number of production and nonproduction paint industry workers in 1987 declined 0.6% from the previous year to 63,000. The decline followed a 0.3% drop in 1986. Between 1978 and 1988, total paint industry employment declined 5700, or 8.3%, and total industry paint production fell 2.7%. Like 1978, paint production reached a peak in 1987 when total production was 1.03 billion gal.

The increasing efficiency is further shown by the number of production workers. In 1978, the paint industry employed 36,200 production workers; in 1987 it employed 30,900, a 15% decline. Employment of nonproduction employees for the same period declined marginally by 1% from 32,500 to 32,100. However, employment of nonproduction workers has declined each year since 1985 when their employment peaked at 33,600. In 1986 the number of nonproduction employees declined 2.7% from the previous year, but in 1987 it declined only 1.8%.

New technology in auto paints

The Detroit auto makers may not be the powerhouses they were in the 1950s when just about every car parked by the roadside in the U.S. was built in the U.S. But Detroit is still pretty much the nucleus of the largest unified automotive market in the world. As such it has become the focus of an intensive fight among paint makers for a larger share of not just the U.S. but the worldwide automotive coatings business.

Each one of the Big Three automotive coatings manufacturers—BASF/Inmont, Du Pont, and PPG Industries—has spent millions of dollars over the past few years to install complex paint applications laboratories. These state-of-the-art, off-site paint production lines are set up not only to duplicate the variety of paint equipment any one car maker may have at a particular site, but also to reproduce the temperature and humidity conditions that can be met on any one car production line.

The paint companies emphasize service through these laboratories because share of market for the paint manufacturer, as well as the auto producer, means keeping up with individual consumer demand for a fashionable, flawlessly finished automobile, on the one hand, and still satisfying government environmental restrictions, on the other. Increasing government scrutiny of VOCs emitted in most wet applied paint systems is a competitive impetus in the automotive OEM paint market.

Slightly fewer than 7.1 million cars were produced in U.S. auto plants in 1987. Including imported cars, dealers sold close to 10.3 million cars last year. That means that one new car was sold for every 18 men and women over the the age of 16 last year. Autos make possible a way of life for the vast majority of U.S. residents. Many depend on their cars in some way for their livelihood. Their cars further make possible a suburban lifestyle, and,

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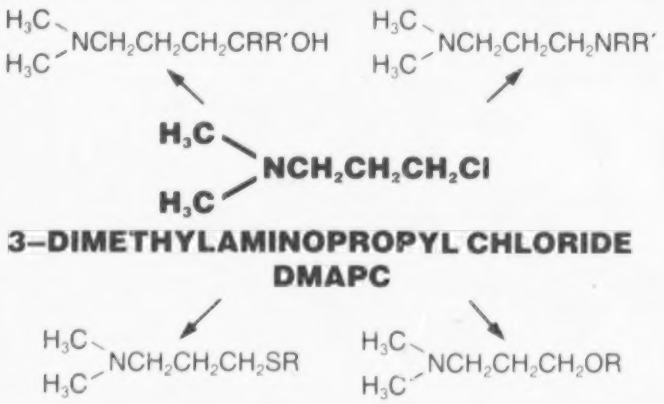

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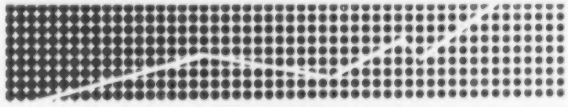

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of course, ownership of particular autos is thought to be indicative of its owners' aspirations and status in life.

Department of Commerce figures show that passenger car sales from U.S. plants declined 5.7% in 1987 from 1986, but sales are still far higher than the 5 million or so vehicles sold during the 1982 recession year. The total market that year for both domestic and imported autos was only 8 million. For the seven-month period January to July of this year, domestic auto production declined 5.9% from the comparable period last year to 4,109,307 units, according to estimates from the Motor Vehicle Manufacturers Association of the U.S. in Detroit. On an annualized basis, that is still a production volume in excess of 7 million vehicles, well ahead of 1982's recession figure. Data beginning in 1987 include the so-called "transplants," such as Honda, Nissan, and Toyota, that have auto production capacity in the U.S.

An average of 6 gal of paint necessary to coat production-line cars from phosphating to top coat means that domestic paint sales to the OEM automotive trade exceed 42 million gal. If the average cost per gallon of paint for product coatings is about the same for 1987 as for 1986, that would put OEM paint sales in excess of $425 million.

Industry analyst Rauch estimates that the combined paint sales of Du Pont, PPG, and BASF/Inmont exceeded $1.25 billion in 1986. Sales figures for the industry leaders include international automotive paint markets as well as other end-use areas for which these giants supply paint. However, each is estimated to supply about one third or slightly less of coatings demand in the automotive business, with others such as Akzo, Bee Chemical, Sherwin-Williams also active in the market.

Analysts also estimate automotive coatings shipments at about 15% of the product finishes category. That estimate can vary 10% in either direction depending on who is making the estimate as well as overall automotive sales and relative demand for other product coatings such as appliances, furniture, and food cans.

The near-term outlook for the au-

tomotive OEM coatings business "looks real good," says Kline & Co.'s Back. The manufacturing base for auto production is expanding in the U.S., he points out, with overseas-based manufacturers setting up factory production in the U.S.

Among these ventures are Toyota's joint manufacturing plant with General Motors in Fremont, Calif., operated under the name of New United Motor Manufacturing, and Honda's Marysville, Ohio, facility. In addition, Nissan, Mazda, and Mitsubishi are expected to be assembling cars in the U.S. by the end of the year. By 1990, Japanese car makers alone may have capacity to build some 1.8 million vehicles in the U.S.

With new players in the domestic market, together with the opportunities and challenges afforded by color changes and improvements in metal flake finishes and the move toward lower-VOC paints, including the introduction of both water-

Worker checks auto finish at PPG's Flint, Mich., coatings applications facility

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Kinzler: leader in top coats

borne paint technology and increasing use of powder coat technology for underhood paint applications, the next few years could prove quite interesting.

Paint makers themselves have moved to shore up their business in automotive paints. Du Pont's acquisition of Ford Motor Co.'s Mt. Clements paint plant in 1986 enlarged its domestic position, and its recently announced joint venture with ICI in Europe should reinforce its reach in the automotive paints business there.

In another recent development, C-I-L Paints, a unit of ICI's Canadian chemical operation, announced its intention to focus on automotive paints and expand into the U.S. auto paint market. Referring to successes in Canada and Europe with waterborne base-coat technology, C-I-L Paints general manager Jacob Shapiro says the "impending free trade agreement with the U.S. makes this an ideal time for us to focus all our resources on serving customers for automotive finishes in both Canada and the U.S."

Assessing the U.S. automotive OEM paint market, Kennard A. Kinzler, group vice president of automotive coatings for BASF/Inmont, says that this is the sixth year in a row in which the automotive OEM paint business has been good. More usual is a three- to four-year up-and-down cycle.

The good business environment has benefited BASF inasmuch as its coatings business takes in every segment of exterior car coats from phosphating the metal body to the final clear coat that finishes and adds shine to a new auto. A joint venture and licensing agreement with Chemetall, a Frankfurt, West Germany-based specialty chemicals company, allows BASF to manufacture and distribute the phosphate coatings needed to pretreat raw metal car bodies before the application of a primer coat. In addition, BASF benefits as a supplier of pigments for its own use as well as to other coatings formulators.

Although it supplies electrodeposition primers as well as the base color coat and clear coat for autos, Kinzler claims, "We're number one in top coats by a considerable margin. You see more of our color on top" than that of other automotive paint suppliers. However, BASF's aim is to supply the entire paint system from phosphate to top coat, thereby securing more business for itself and giving the auto assembler a single entity fully accountable for the quality of coatings supplied for the assembly line.

Ultimately Kinzler envisions a time when BASF could be responsible for managing the auto maker's paint facilities. BASF has the capability to manage such an effort, Kinzler believes, but that will only happen "if the auto makers want it."

BASF's Kinzler talks so confidently about his company's ability to manage paint applications for auto makers because of the company's new $16 million investment in its automotive applications research center in Southfield, Mich., and because of the $45 million expansion of its OEM lab and engineering research facility now under construction at the same site.

According to Lloyd E. Altamirano, the applications lab contains a 22,000-gal electrodeposition tank allowing the lab to dip prime an entire auto body. The 40,000-sq-ft facility also contains an accompanying 2200-gal small-parts dip tank, a 16,430-gal rinse tank, and a radiant convection oven. In the spray line, an auto body moves through a

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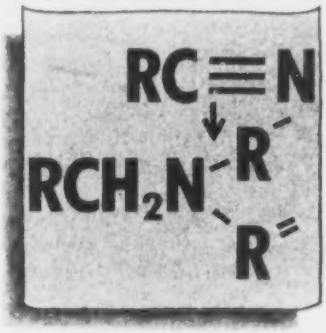

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manual spray application booth, and then on to an automatic spray zone where paint can be applied via electrostatic turbobells and reciprocators. A developmental forced flash tunnel at the end of the line combines forced air and infrared heating. "Everyone in this lab is a chemical engineer. Most have their master's or Ph.D.," says Altamirano. And it costs BASF about $5 million annually to operate the facility, adds Kinzler.

In addition to working out paint application problems for the Detroit auto makers at the lab, European manufacturers have shipped entire car bodies to the facility for painting as well. Among them are Daimler Benz, Volvo, and Saab, Kinzler says.

BASF's engineering research facility now under construction will have close to 250,000 sq ft of lab space when it is completed, says James W. Benefiel, product development director of automotive research. About 400 people will work at the lab when it is finished, he says, up from 200 working in the lab at present.

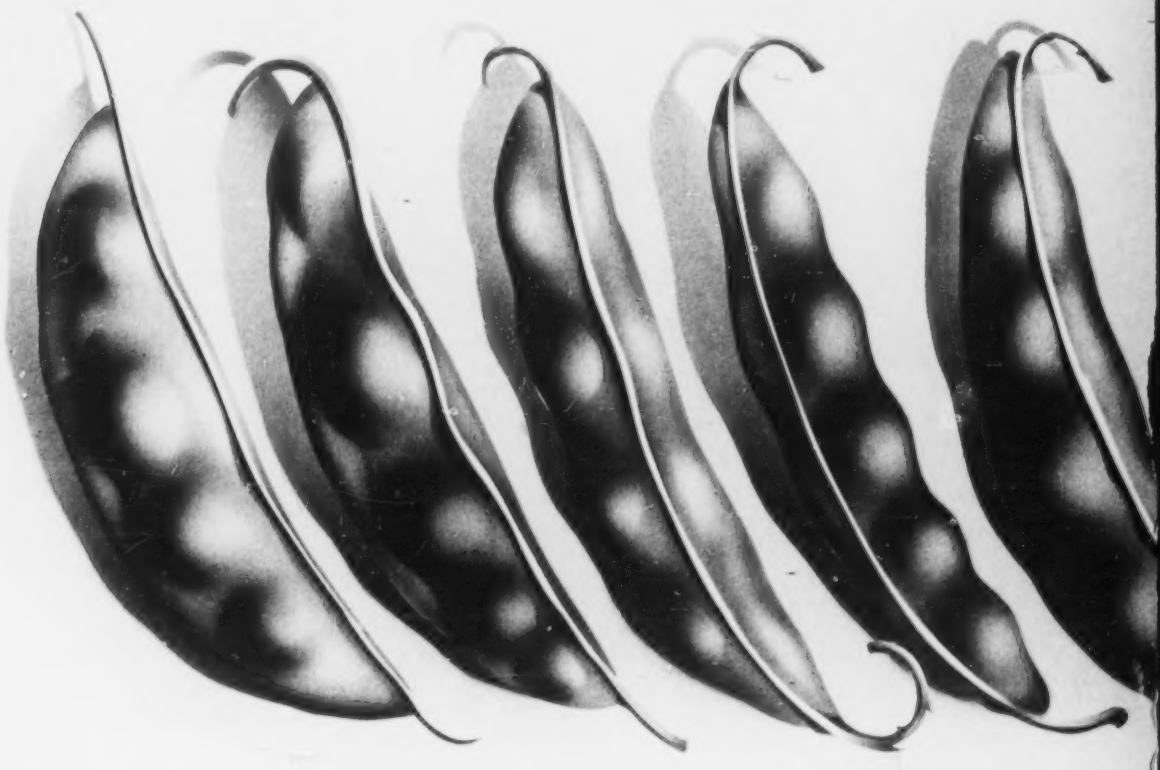
"Helping our customer compete has become part of our job," says Kinzler. "It wasn't that way 30 years ago, but it is today." High-solids color base coats combined with high-solids clear coats have helped auto makers to produce "prettier, brighter, and cleaner colors," not possible with the older acrylic enamels and acrylic lacquers. At the same time, the high-solids formulation has helped reduce VOC problems.

The next step is to introduce a water-based color coat. In addition to even lower VOCs, the new water-based formulas allow "easier, more foolproof" application, and "even better orientation of the aluminum flakes" used in metallic finishes "for even better color." A General Motors plant soon plans to use the new water-based color coat, he says.

More durable clear coats are also a research objective, says Kinzler. BASF is researching urethane and other resin chemistry. He says that one auto maker is applying a polyisocyanate-containing clear coat formulation on the production line now and that, depending on the results on the road, it may expand the technology to its other production lines.

Du Pont also has invested heavily in automotive applications research facilities. Its Troy, Mich., lab opened in February of this year. The 36,000-sq-ft applications lab represents a $17 million investment, says Ronald F. Ellis, manager of the facility. Like BASF's, the new lab can simulate actual production-line application conditions, and includes manual as well as robotic spray zones, a convection oven, and a high-velocity flash oven containing laser-plated gold walls and ceilings for infrared efficiency for waterborne finish research.

Du Pont's interest is not just lim-



ited to coatings. Its presence in Troy represents its strength as a supplier of plastics and electronics materials as well. Says Robert P. Strazella, currently marketing services manager of automotive finishes, Du Pont's automotive products sales exceeded $2 billion in 1987. The Troy site, adjacent to General Motors' new Saturn Division headquarters, is home base for 1300 Du Pont research and sales people and world headquarters for the automotive products group. Ten years ago, only 155 people were located in Troy.

Du Pont's stance in the automotive coatings business in particular is an aggressive one. It purchased the Mt. Clements coatings operations owned by Ford in 1986 and more recently strengthened its hand in the European automotive OEM market in a venture with ICI. Technical group manager for automotive finishes Robert L. Turner expects Du Pont's OEM coatings business to grow 1 to 2% in excess of the OEM market and confesses that the only way to do that in the future will be to increase its market share at the expense of its competitors. Turner says that Du Pont's low-VOC paint technology will help the company expand in Europe, too. "They gave us the wet look, we will be able to give them systems with lower VOCs."

Like its competitors, Du Pont sees its strength as a provider of not just coatings but also service to the auto makers who use Du Pont coatings. And like its competitors, it is prepared to operate assembly-line production units for auto makers. Du Pont recently built a plant in Kansas City, Kan., where it manufactures and paints front and rear bumper fascia for delivery to a nearby General Motors assembly plant for just-in-time assembly of Pontiac's Grand Prix, says Turner.

For the future, he says, he believes basic clear coat and top coat technology will continue to be based on acrylic resins. However, he expects to see more polyester resins in combination with acrylics, though the polyester formulations need not necessarily contain polyisocyanates. The key, he says, is putting all the necessary technology together for formulations. A new proprietary technology recently developed by Du Pont and which it calls group transfer polymerization is a technique that allows the formulation of a 3 to 4% higher-solids-content, solvent-borne color coat. The resulting paint, just introduced in red, yields better color and lower VOC levels, Turner says.

Currently, he adds, Du Pont is strong in water-based color coat and solvent-based clear coat technology. The waterborne color coats enhance the appearance of the paint, notes Jack Vallance, Du Pont's automotive finishes color marketing specialist. "It allows us to return to low-solids applications," he says, thus giving finer metallic paint

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finishes than can be achieved currently with high-solids, solvent-borne paint systems. An advantage to paint systems that contain a waterborne solids color coat is that they allow car makers to meet all current VOC regulations while giving consumers a better-looking paint job, he says.

In addition, Vallance believes that waterborne color coats will allow fancy finishes unachievable with high-solids solvent paints. Not only do metal flake color finishes look better with waterborne applications, but custom names, for instance, can be painted on car decks without resorting to decals, he says.

Du Pont is also putting research efforts into two-pack clear coat systems, which contain a catalyst to enhance the curing of the top coat and thus may increase the protection afforded the base color coat. But, says Turner, the two-pack systems need not necessarily contain polyisocyanates. Du Pont, he says, is looking at the systems both with and without polyisocyanates.

Powder coatings may also have a future in automotive exterior paint applications. Du Pont has a technology base in powder coatings, Turner says, and it remains committed to this technology through a subsidiary operating in Spain. It's possible that powder will find its niche as a chip primer applied between the electrocoat primer and the top coat where it would provide protection from pebbles kicked up along the roadside, he says. It is even possible one day that clear powder coats may provide the top coat.

Although plastics are not assembled on line before the body is painted, that may change one day. As auto makers look to more cost-effective assembly methods, a paint system that allows coating as many body parts as possible at the same time would not only reduce costs, but might also allow for better color matches, Turner says. That is one reason why paint producers including Du Pont are researching paint systems that allow oven cure of paint on auto assembly lines at 170 to 180 °F.

Temperatures along paint lines today typically reach 250 °F, but plastic parts would distort at that temperature, Turner notes. The 170- to 180-°F range could allow on-line coating of preprimed plastic parts, he says. Such a universal paint system is not a new concept, he notes, but right now the aim is to achieve a universal color coat for both the body on-line and off-line parts to achieve the best color match possible. The next goal would be to achieve an on-line universal paint ability.

Du Pont attempts to predict color demand three years ahead of a model year. In that way, the company can formulate and test the colors so it knows they will endure under long exposure to bright outdoor light.

"We check industries where color may be a factor in determining preferences by consumers for car colors," says Vallance. Men's fashions and interior design colors are two areas of inspiration, he says.

PPG also offers a full range of automotive coatings from phosphate to top coat. The company holds the key patent for electrodeposition primer coating technology utilized in two thirds of worldwide vehicle production, and licenses its competitors to sell primers based on the technology. It acquired Chemfill in 1986, giving it the ability to supply phosphating chemistry.

E. Kears Pollock, PPG director of automotive products, sets the company's automotive product business at $1 billion annually worldwide. That number includes PPG's position as a supplier of not only coatings, but also window glass and glass-fiber reinforced plastics for body panels.

PPG also has a new applications lab under construction in Troy, Mich. But lest it seem that PPG is playing a catchup game with its two major competitors, Pollock points out that PPG for years has had a Detroit area facility in Flint, Mich., capable of testing full body automotive paint applications. It also is nearing completion of a small body parts test paint application facility in the Cleveland area, he says.

The reason for the proliferation of test labs is that technology in the automotive industry is changing so fast that there is a need to test applications under real conditions, says Pollock. Auto makers want to optimize paint performance before they make the commitment to try out

Pollock: a $1 billion business annually

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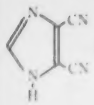

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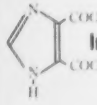

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the new techniques on their production lines.

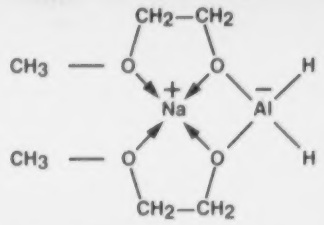
Pollock says that auto coatings markets are strong now in Europe and North America and likely will continue strong. The Pacific area market is not so strong as it was in the past, mostly because of the relative strength of area currencies relative to the dollar. Many changes in the North American and European markets are now under way, mostly because of Asia-based manufacturers who are setting up assembly plants in both Europe and North America, Pollock says.

New developments from PPG include a powder antichip coat applied to the car body just after the electrocoat primer but before oven curing. The powder is designed to be compatible with the primer, says Pollock, and gives added antichip protection without any increase in emissions. Like its competitors, PPG has introduced new color primers that coordinate better with top coats for improved color coat appearance.

Waterborne base color coat technology is advancing, he says, as improvements in paint chemistry allow applications of waterborne formulations under a wider range of temperature and humidity conditions. The challenge in installing more waterborne systems is not only in improving the paint itself, but also the equipment. Black iron pipes deteriorate when waterborne paints flow through them. More expensive stainless steel pipe is the alternative. Where manufacturers don't want to make the investment in new pipe systems, PPG continues to develop high-flow, solvent-based solids paints that give the appearance of waterborne coatings, Pollock says.

Where some manufacturers want the flexibility of using waterborne technology for lighter-colored metallic paints and solvent paints for darker colors, PPG is ready to supply them, says Pollock. "We don't think the arguments in favor of waterborne paint systems provide an open-and-shut case. We give manufacturers the option to choose."

As for clear coats, there has been a lot of interest over the years in polyisocyanate-containing clear coats because of their good appear-



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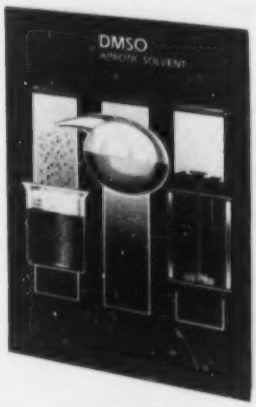

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ance and durability, says Pollock. However, because of the inhalation hazards associated with polyisocyanates, PPG has looked into alternatives. The company recently has commercialized a two-pack clear system without polyisocyanates—NCT Clearcoat—that is currently being used by Chrysler, Pollock says. He adds that he expects the technology to move to other automotive product lines in time.

"There is a lot of evidence to show that polyisocyanate-containing coatings can be used successfully," says Pollock, but the jury is still out. "Our approach is to proceed with an abundance of caution. We'll give the auto manufacturers the option."

All the major paint producers say they are providing more service these days to their customers via application lab facilities, as well as more service at customer sites. PPG engineers are responsible for paint applications at one General Motors plant. But what is important in this particular instance is not that the paint manufacturer has paint detail responsibility, but that a team of experts is free of administrative burdens and allowed to focus on the painting process.

The team approach allows a "substantial reduction of costs because of less waste," says Pollock. There are also fewer disposal problems because the volume of overspray at the plant has been reduced. Although in the end PPG may sell less paint, Pollock says that PPG "shares the savings" with General Motors through formulas in which "everyone is encouraged to be more efficient."

C-I-L Paints' Shapiro says that the entry of Japanese auto makers in the North American car assembly market affords C-I-L and its parent company, ICI, opportunities in the U.S. as well as the Canadian OEM paint market. Both C-I-L and ICI recently entered into a technical cooperation agreement with Nippon Oil & Fats Co. The Japanese paint producer supplies both Honda and Nissan in Japan.

The agreement with Nippon Oil & Fats already has helped C-I-L gain new business. C-I-L now supplies the new Honda assembly plant in Alliston, Ontario, Shapiro points out.

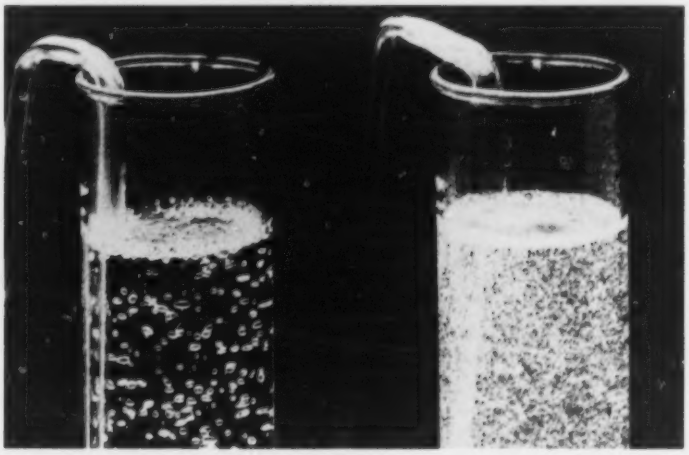
Shapiro believes that C-I-L is in a good position to compete with BASF, Du Pont, and PPG because of its recent agreement with Nippon Oil & Fats and also because it has the resources of ICI behind it. "We're competing with them in Canada," he says. Shapiro adds that he doesn't see C-I-L overtaking the Big Three in the U.S. market—"we're not large enough yet." There are "areas of opportunity," however, that should allow C-I-L to grow.

In addition to new business with the foreign companies that have auto production plants in the U.S., C-I-L's Aquabase waterborne color base coat paint technology allows it to offer a base coat/clear coat system to auto assemblers, Shapiro says. Thus it can compete directly with the three big U.S. suppliers in offering paint systems that conform to government VOC emission regulations.

Aquabase is used at a General Motors truck assembly plant in Oshawa, Ontario, and has been introduced in Sweden via ICI into Volvo's production lines, he says. "This gives us credibility. It opens the door for us in OEM in a number of areas," he adds.

Like BASF, Du Pont, and PPG, ICI is a major world plastics and automotive materials supplier. It opened a Detroit automotive service facility within the past few months, Shapiro points out. And C-I-L plans to install an automotive paint applications center in Toronto next year, he says.

As part of its efforts to beef up its production capability, C-I-L plans to spend $1.6 million (U.S. dollars; $1.00 = 1.236 Canadian dollars on Sept. 6) at its York Works manufacturing facility in Toronto. Paint production from that facility is aimed at the automotive OEM and refinish markets. C-I-L Chemical, of which C-I-L Paints is a unit, has sales of $1.05 billion. Shapiro says



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the company does not break out paint sales separately.

Despite skepticism about the utility of two-pack polyisocyanate-containing paint systems by the major paint manufacturers, Mobay, the main industry polyisocyanate supplier, is confident that such systems can be safely applied. G. Thomas Harrick, vice president and general manager of Mobay's Coatings Division, notes the safe, wide use of polyisocyanate-containing two-pack systems in the automotive paint refinish business. He hopes to see more of a shift to their use in the OEM finishes market.

Advantages of alkyd or acrylic paint systems modified with a polyisocyanate crosslinking agent are increased resistance to gasoline spills, higher resistance to natural and artificial environmental effects from squashed bugs to acid rain, as well as a long-lasting higher and deeper gloss, says Volker Mirgel, technical marketing manager of transportation coatings.

In addition, the polyisocyanate crosslinking agent means that auto makers could operate with lower oven temperatures to cure the paint, says Harrick. Two-component polyisocyanate-containing systems also allow car makers to comply with environmental regulations, says Mirgel. More stringent environmental regulations in West Germany forced Daimler Benz to find a lower VOC paint system that would still provide a high-quality finish. The company chose a two-component system.

Mirgel explains that using a two-component top coat containing polyisocyanates allows application at relatively low viscosity. Because the polyisocyanate is added just before the spray reaches the car surface, the high-solids polymer forms on the surface of the car. In addition to lowering VOCs, the system produces a Mercedes off the paint line with a higher-gloss, smoother, more cleanable, and more durable surface. The finish also has better resistance to chemical degradation. And the system produces a more flexible film allowing a higher finish chip resistance, says Mirgel.

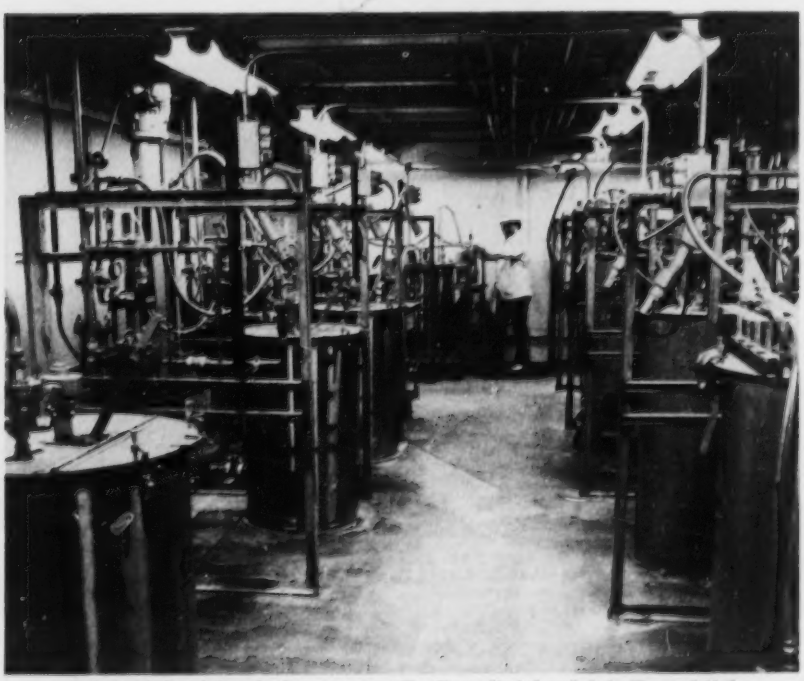
European car makers are more advanced than their counterparts worldwide in the use of new two-pack urethane technology, Mirgel says. Volkswagen already has a "test" paint line applying the two-component paints to 600 cars a day. The former Chrysler plants in France, now run by Peugeot, have been using the two-component systems for some time, he says. And Renault's Alpine and R-5 turbo, which both use a number of plastic components, have been using two-component urethane systems since the mid-1970s, he says.

Japanese car makers, Mirgel says, have been somewhat slower to adopt the two-component urethane systems. Nissan has started to produce its low-volume President sedan in Japan with a two-component urethane and plans to convert higher-volume production lines to the two-component clear top coat system within the next year. Toyota has not yet adopted the two-component system. Japan has no VOC emission regulations to act as an impetus. But although vehicles intended for the home market have no acid etch problems, the high number of cars subject to that problem when the cars are exported to the U.S. has made two-component urethane clear coat technology an important consideration for Japanese car makers, he says.

Ford's recent introduction of a two-component system at a Canadian assembly plant has been accepted by the Canadian Auto Workers Union, says Mirgel. Although Mirgel admits it's true that polyisocyanates do not have the best reputation, they can be applied safely. Mobay assisted Ford and its employees with toxicology data and helped set up an air-sampling monitoring program and a medical program for employees who might come into contact with the paint system. "We were open to gain their confidence. We didn't hide anything," says Mirgel.

There is a big difference, Harrick says, between methyl isocyanate implicated in the industrial disaster at Bhopal, India, and the polyisocyanate. Because of that disaster, "isocyanate" became a bad word, he says. But polyisocyanates used in paint have much lower vapor pressure, volatility, and toxicity than do methyl isocyanates, says Harrick. They are not based on methyl isocyanate, he stresses.

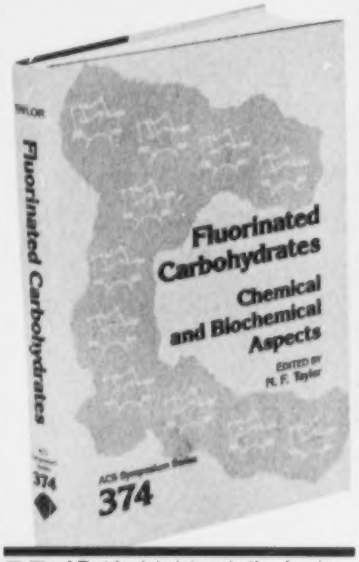
Workers must be protected when any type of paint is sprayed, and that is especially true of polyisocyanate-containing paints, Harrick says. Inhalation of spray does



Paint mixing/circulation room at Du Pont finishes lab in Troy, Mich.

Fluorinated Carbohydrates

Chemical and Biochemical Aspects



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Mobay's Harrick and Mercedes 190E top coated with two-component urethane

cause eye and respiratory irritation, but that is a positive sign, says Harrick. "You know right away that something is wrong." Solvents used in acrylic enamels may not cause immediate discomfort, but they may accumulate in the liver and cause a person problems in 20 years. Workers exposed to polyisocyanate-containing spray know something is wrong immediately and recover as soon as they are no longer exposed, he says.

The material cost for manufacturers to convert to paints containing polyisocyanates is not large, according to Harrick. Economies can be achieved, as was the case for Daimler Benz, which went from four-color coats to three with no loss in appearance because of the two-pack top coat.

Although Mobay is not a paint manufacturer per se, it does have an interest in raw materials for urethane coatings used in OEM automotive applications. It also supplies items such as thermoplastic resins, rubber chemicals, and pigments for the automotive business. It, too, recently opened a technical marketing center in Troy, Mich., which encompasses more than 18,000 sq ft of space, and is also linked to research labs at Mobay's Pittsburgh headquarters.

Dow Chemical is also a large supplier to the automotive business. According to Charles M. Olson, development leader in the chemicals and pigments department, the company has been instrumental in the conversion of solvents used in the industry from ethylene-based to propylene-based glycol ethers. The propylene-based solvents offer two advantages: They have lower toxicity than their ethylene-based cousins and they are more active solvents, helping manufacturers solubilize higher-solids paints.

The company, which in addition to solvents sells polymers and resins used in the automotive industry, has a Detroit area staff to coordinate the company's marketing efforts to the automotive trade. In addition, Dow is a supplier of epoxy powders used to coat under-the-hood components.

Polyester powder coats have also been used increasingly for this purpose. According to Walter F. Johnston, polyester products research engineer at Goodyear Tire & Rubber, one area in which the polyester powders have gained acceptance is as a coating for oil-filter housings. Goodyear, he says, produces and polymerizes polyester resins for powder coatings, which manufacturers such as Glidden, H. B. Fuller, O'Brien, and others convert to powder coatings.

The technology has good growth potential because it offers not only good appearance and exterior durability but some significant environ-

mental advantages not inherent in paint. The oven-cured powders do not emit VOCs and any powder overspray can be cleaned and reused, eliminating the overspray disposal problems inherent in wet-applied paints, says Johnston.

However there are some disadvantages to powder coatings. High oven temperatures (340 to 425 °F) are now required to cure the paint, Johnston says. Those temperatures are not practical for coating most plastic parts used in autos. In addition, manufacturers must install special handling equipment for using powder coatings.

The success of different paint producers and various coatings technologies will depend in large measure on the strength of U.S. auto production. With the more competitive dollar, North American auto makers may begin to export cars in large enough numbers to have a real impact.

But should exports surge, will they come from U.S.-based auto makers or will they originate from plants set up by the "transplants?" If the "transplants" increase their exports, will they buy from the established North American suppliers or will foreign-based paint producers set up their own transplants?

Apparently U.S.-based paint producers are not leaving anything to chance. Their new paint applications facilities and the millions spent on them indicate the producers' willingness to invest big dollars in a business that may only grow 1 to 2% annually. And apparently they see it as a key to growth in sales of other materials they supply either directly or indirectly to Detroit.

Performance materials and specialty paints

Performance paint materials and specialty paints can cover a wide range of applications. Some new materials that have not been widely used, however, are now generating interest and these include organic titanates, biocides, fluoropolymers, and antirust polymers. In addition, recent advances in perfluoroalkoxy (PFA) coatings technology have paved the way for producers to open a new market in high-performance

Goldbaum: titanates used for 40 years

coatings for pharmaceutical and chemical process equipment.

Organic titanates have been used in paints and coatings in some limited ways over the past 40 years, according to Richard H. Goldbaum, senior technical service chemist with Du Pont's performance chemicals group. Recent applications research has found that organic titanates are good coupling agents in paint, can provide better quality and higher yield than acid catalysts in resin manufacturing, can increase paint barrier properties aiding in corrosion resistance on metal substrates, and can help reduce viscosity in some high-solids paints.

As a catalyst in the manufacture of resins, organic titanates also can produce faster reactions and, because they are gentler catalysts than acid catalysts, they produce fewer by-products, says Goldbaum. As surface modifiers, the titanates cost less than silanes for most applications except where adhesion to glass is a factor, he says.

Organic titanates are derived from ilmenite ore, the same source from which the premier white paint pigment titanium dioxide is obtained. Organic titanates cost between $2.00 and $6.00 per lb, says Goldbaum.

John Sices, product marketing specialist for Witco's Sonneborn Division, says the firm's SACI corrosion-prevention resin has found new life with applications in corrosion protection on industrial structures such as bridges and parking garages. For the past 20 years the SACI resin's primary use has been in the automotive market, where it has found a niche as a coating on automotive underbodies and automotive inner panels.

Hardness and abrasion resistance are not a strong point of these resins, points out Sices. However, because they have excellent metal adhesion and peeling resistance, SACI resins can provide protection where internal protection of metal structures is a problem.

Angus Chemical, Northbrook, Ill., recently has added a line of mildewcides to complement its line of in-can bactericides. In April of this year it bought Abbott Labs' Amical mildewcide business. According to John F. Alderman, product development manager, Amical is an iodine-containing organic sulfur compound.

Amical is primarily used now in adhesives, caulks, and sealants, Alderman says. Although it has been used in some prepared paint formulations, its biggest potential market is as an additive for architectural coatings. Another major use for Amical may be as an additive for stucco coatings on homes in humid climates, he says. "Safe handling and low toxicity are its major attributes," he adds.

Fluorochemicals comprise anoth-

Rao: super durable coatings

Edlon's Jenson with coating specialist and his coating equipment

er group of chemicals with potential for modifying paints. Fluorochemicals already serve several functions, says Du Pont research scientist Nandan Rao. As surfactants, they provide excellent spreading and wetting abilities. As fluoropolymers, they may be incorporated in traditional coatings to give them increased water and oil resistance as well as increased durability to ultraviolet exposure. Rustoleum, for instance, recently has introduced a wood paint for the retail market incorporating Du Pont's fluoropolymer.

Fluoropolymers also may be used in furniture finishes to provide an ultraviolet-curable "super durable" coating, says Rao. In addition, they may be used on on-line factory production equipment to provide mold-release properties where materials might otherwise stick to a fabrication mold.

New fluoropolymer-containing proprietary paint systems that make possible the coating of intricate shapes have recently come into the marketplace from at least three different companies. Edlon Products of Avondale, Pa., Ispa Plastics of Baltimore, and W. L. Gore & Associates of Elkton, Md., all offer perfluoroalkoxy coatings for use in extremely corrosive environments.

According to Bernard Jenson, applications manager for Edlon, the company has had extensive experience in the application of "Teflon loose liner" [polytetrafluoroethylene (PTFE) sheeting] to conform with interior vessel surface. Its new SC-7000 coating system allows Edlon to spray apply a 0.40-inch thick, corrosion-resistant barrier without pinholes or flaws that can give complete coverage to highly complex shapes.

The coating, he says, is very useful in reactor vessels where acids and caustics are mixed and where glass-lined vessels won't work. In addition to having a low coefficient of friction, it is serviceable at temperatures as high as 350 °F. PFA-coated distillation columns have been used to clean up acids in air by concentrating them into a liquid and have given good results.

The coating bonds best to carbon steel, a relatively inexpensive material. However, the cost of applying the coating varies from $100 to $200 per sq ft, depending on the complexity of the shape coated, says Jenson.

As much as 16 hours may be required to properly coat a part, he says, during which application of the proprietary dry blend powder coating is built up in successive layers and baked on in special high-temperature ovens on-site. The company has the capability to coat parts with a maximum size of 6 feet × 6 feet × 10 feet, he says.

Edlon has annual sales of $8 million to $10 million. Edlon's new president, Earl H. Levith, says that the market for his company's new PFA coating should considerably swell that figure. A former manager at Occidental Chemical, he believes that the market for PFA-coated vessels can run as high as $20 million to $30 million annually and that Edlon will be the key player in that market.

Levith says he aims to take sales up to $25 million to $30 million within the next five years. PFA spray-applied coatings have potential not only in high-temperature and corrosive environments but in applications where a pure product is required. Industries requiring the coating and which might help Edlon generate the level of sales Levith projects include the pharmaceutical, chemical process, and electronics industries. He hopes also that food processing will provide a market for the coatings. The company is now looking into FDA approval of the coating's use on food processing equipment. "That is a whole coating area that is virtually untapped," he says. He adds that Edlon is talking to candy, taffy, and chocolate makers, who could offset much of the cost of the coating in savings in the cost of solvents and cleaning materials used on their food-processing equipment.

Karen J. Bolin, sales manager for Ispa Plastics, a privately held company that mixes, develops, and applies specialty coatings systems, says Ispa Plastics also has a proprietary process to apply PFA coatings to processing vessels. Cost, she says, depends on the size and complexity of the part to be coated with the 0.40-inch-thick coating, but ranges between $60 and $125 a sq ft. However, the coating is cost-efficient for many users considering the cost of specialty metals, she points out. She estimates that 30 to 50% of vessels that are now glass-lined eventually might be coated with PFA.

Gore is also a factor in the PFA coatings business with a product it calls Fluoroshield. A company data sheet claims that Gore's coating can be applied up to 0.60 inch thick and provides "universal chemical resistance (0 to 14 pH)" with an "operating temperature range of −190 to 260 °C." □